

MEMORANDUM

To: Ag/Urban Technical Team
From: Dave Schuster
Date: January 17, 1997
Subject: Update on operation studies.

Surface Water Resources, Inc. staff have modified the DWR operation model significantly. There were two reasons for the coding changes. The first was to be able to use the model to deliver water developed by a new storage reservoir for any of the following purposes:

- 1) Deliver water to either the SWP and/or CVP water users.
- 2) Deliver water for any environmental enhancement purpose including instream flow increases, export reductions during periods important to fish survival, and increased in-Delta flow requirements.
- 3) Deliver water to users in the Sacramento Valley.

The first change required separating water developed by new storage reservoirs from the Coordinated Operations Agreement split routine.

The second was to expand the capability of the in-Delta subroutine so that changes in Delta operation criteria can be accurately modeled. This allows for diversions to Los Vaqueros Reservoir and accurate studies regarding various size isolated facilities, flow requirements, and pumping restrictions in the south Delta.

The results from the new model have been checked thoroughly and the coding changes shared with DWR and CALFED staff.

Most of the studies done to calculate the benefits of the Dual system have been redone and the results change by insignificant quantities.

This model has been used to test the following possible Ag/Urban Caucus Systems Subcommittee alternatives:

- 1) A 1.2 MAF and 1.9 MAF surface storage facility at the Sites site plus a 7,500 cfs isolated facility.
- 2) A 1.0 MAF Los Vaqueros Reservoir plus a 7,500 cfs isolated facility.

- 3) Various sizes of the isolated facility designed to provide appropriate, in F&WS and F&G's opinion, export levels from the south Delta during periods critical to fish survival.
- 4) A 1.2 MAF Sites Reservoir combined with a 1.0 MAF Los Vaqueros Reservoir plus a 7,500 cfs isolated facility.

The results of those studies are discussed in the remainder of this memorandum.

Sites Project

This study assumes a 7,500 cfs isolated canal that includes the following:

- 1) A fish screen and pumping plant at Hood on the Sacramento River.
- 2) A 7,500 cfs canal from Hood to Clifton Court Forebay.
- 3) An interconnection between the Tracy Pumping Plant intake channel and Clifton Court Forebay.

This study uses the Ag/Urban Technical Team's Delta operation criteria which are the Delta Accord standards¹ with the following adjustments:

- 1) More restrictive export to Delta inflow ratios than the Delta Accord restrictions during the 31-day San Joaquin River spring pulse flow and the November through January period.
- 2) The Delta Cross Channel gates are closed at all times except the gates can be opened during the year for short periods if required to maintain central and south Delta water quality.
- 3) Increased Sacramento River in-Delta transport flows measured at Rio Vista.

The Sites Project studied includes the following facilities:

- 1) A fish screen and pumping plant near Red Bluff Diversion Dam. The capacity of the pumping plant would be equal to the capacity of the Tehema-Colusa and Corning canals. The Red Bluff Diversion Dam gates would be closed for recreation during periods that are not detrimental to any anadromous species.

¹ No changes to the Delta Accord Delta outflow requirements including the X2 requirements.

- 2) A diversion facility off the Tehema-Colusa Canal with a pumping plant for diverting water into Sites Reservoir. The pumping plant capacity would be equal to the capacity of the Tehema-Colusa Canal at the diversion point (about 2,100 cfs).
- 3) Facilities to allow water to be released from the reservoir back to the canal equal to the pumping plant capacity.
- 4) An interconnection between the Tehema-Colusa Canal and the GCID system.
- 5) A release point from the Tehema-Colusa Canal into the Colusa Basin Drain. Sites Project water would be delivered through the drain to the Sacramento River at Knights Landing. There are other options for getting water from the Sites Reservoir to the Sacramento River but this option seems to be the least costly at this point. (One problem is whether or not this water can be protected against illegal diversions in the drain.)

The Sites Project allows about one half of the Tehema-Colusa and Glenn Colusa canals service area existing contractual deliveries to be met through releases from the Sites Reservoir. That allows water to be left in Shasta Reservoir for other purposes. Water can also be released directly to the Sacramento River and used to meet Delta flow requirements. This too allows for water to be left in Shasta, Folsom, and Oroville reservoirs for meeting other purposes. Water developed by the Sites Project can be used to meet 100% or less of any of the following purposes:

- 1) Environmental enhancement measures including increased instream flows below any SWP or CVP reservoir, increased Sacramento River in-Delta transport flows measured at Rio Vista, reduced CVP and SWP export pumping from the south Delta during periods important to fish survival, and increased Delta outflow.
- 2) Meeting northern California's current and future water supply needs.
- 3) Augmenting the existing CVP and SWP south of the Delta water supplies.

1.2 MAF Sites Reservoir

If the water developed by a 1.2 MAF Sites Project is used a) for northern California agriculture and those users have an alternative supply such as groundwater or those users are willing to accept large deficiencies during drought periods or b) for environmental enhancement and it is decided to use that water to improve habitat conditions during non-drought periods for the purpose of increasing fish and/or waterfowl populations in those years so the species can better cope with drought conditions, then the project can deliver 400,000 AF in most years with average annual deficiencies of:

Period	% Deficiencies
1929-34	65
1948-50	18
1987-92	25

If the water developed by a 1.2 MAF Sites Project is used a) by northern California urban water users and those users want a very reliable water supply even during severe drought conditions or b) for environmental enhancement and it is decided to use that water to improve habitat conditions during drought periods for the purpose of increasing fish and/or waterfowl survival in those years, then the project can deliver 300,000 AF in all years except during the 1929-34 period when an annual deficiency of 33% would be imposed in each of those six years.

If the water developed by a 1.2 MAF Sites Project is used to meet CVP and SWP unmet demands south of the Delta at the current demand level, the average annual increase measured in thousands of acre-feet in deliveries over a base that includes the 7,500 cfs Dual facilities and existing storage facilities would be:

Period	Base Delivery	Delivery with a 1.2 MAF Sites Reservoir	Difference
1922-92	5,472	5,801	329
1928-34	4,149	4,353	204
1986-92	4,345	4,768	423

Much of the water transferred from the Sites Project to the users south of the Delta with the 7,500 cfs Dual water transfer facilities must be pumped from the south Delta. The average monthly export to inflow ratio for the base with the increase in the export to inflow ratio caused by transfer of Sites Project water shown in parenthesis are:

Period	1922-92	1986-92	1928-34
Oct	0.26 (0.01)	0.13 (0.00)	0.16 (0.00)
Nov	0.24 (0.01)	0.23 (0.01)	0.26 (0.02)
Dec	0.20 (0.02)	0.29 (0.02)	0.28 (0.00)
Jan	0.15 (0.01)	0.28 (0.02)	0.31 (0.00)
Feb	0.06 (0.02)	0.04 (0.02)	0.11 (0.03)
Mar	0.07 (0.03)	0.12 (0.07)	0.11 (0.03)
Apr	0.22 (0.03)	0.26 (0.07)	0.27 (0.01)
May	0.08 (0.01)	0.13 (0.00)	0.11 (0.02)
Jun	0.27 (0.03)	0.18 (0.04)	0.11 (0.00)
Jul	0.12 (0.05)	0.05 (0.04)	0.06 (0.00)
Aug	0.11 (0.02)	0.06 (0.00)	0.05 (0.00)
Sep	0.30 (0.02)	0.26 (0.04)	0.20 (0.00)

The export to Delta inflow ratio increases due to transfer of Sites Project water to water users south of the Delta do not seem significant except possibly March, April, and June. As a final check, the average monthly increases in export levels for the months key to the fishery were calculated. The average monthly south Delta export for the base with the increase in the exports caused by transfer of Sites Project water shown in parenthesis are

Period	1922-92 (cfs)	1986-92 (cfs)	1928-34 (cfs)
Oct	2,980 (60)	935 (0)	1,375 (0)
Nov	2,855 (85)	1,500 (0)	2,390 (0)
Dec	3,010 (210)	2,390 (185)	2,685 (15)
Jan	2,340 (165)	3,665 (80)	3,495 (25)
Feb	1,745 (455)	1,380 (560)	1,925 (345)
Mar	1,380 (520)	2,720 (1,030)	1,680 (450)
Apr	4,670 (590)	4,770 (815)	4,170 (315)
May	1,625 (50)	1,621 (0)	1,290 (200)
Jun	5,480 (185)	3,130 (440)	1,590 (90)

From a fishery biologist perspective, the above increases in south Delta exports due to the transfer of Sites Project water are not significant except possibly in March, April, and June. The problem with these months is that the fishery biologist will likely consider the base pumping levels higher than optimal and any increase in exports due to Sites Project are significant. The model moves water from Sites Reservoir in those months in an attempt to fill San Luis. That water could be moved in July and August (a more fish friendly period) and achieve the same purpose of maximizing project deliveries. Therefore, Sites Project water could be used to augment CVP and SWP water supplies south of the Delta without negatively impacting fish with a 7,500 cfs. A larger isolated canal is not needed to implement the Sites Project if the water is going to be used by the CVP and SWP.

1.9 MAF Sites Reservoir

The 1.9 MAF Sites Project assumptions are the same as 1.2 MAF project discussed above except the reservoir can store 1.9 MAF.

If the water developed by a 1.9 MAF Sites Project is used a) for northern California agriculture and those users have an alternative supply such as groundwater or those users are willing to accept large deficiencies during drought periods or b) for environmental enhancement and it is decided to use that water to improve habitat conditions during non-drought periods for the purpose of increasing fish and/or waterfowl populations in those years so the species can better cope with drought conditions, then the project can deliver 400,000 AF in most years with the following average annual deficiencies:

Period	% Deficiencies
1929-34	50
1948-51	0
1987-92	0

If the water developed by a 1.9 MAF Sites Project is to be used a) by northern and/or southern California urban water users and those users want a very reliable water supply even during severe drought conditions or b) for environmental enhancement and it is decided to use that water to improve habitat conditions during drought periods for the purpose of increasing fish and/or waterfowl survival in those years, then the project can deliver 300,000 AF in all years except during the 1929-34 period when an annual deficiency of 10% would be imposed in each of those six years.

No study was done to determine the potential benefits of dedicating the 1.9 MAF Sites Project developed water to water users south of the Delta. The average annual benefits would be about the same as the 1.2 MAF project and the drought benefits could be as much as 100,000 AF per year greater than the 1.2 MAF project.

Los Vaqueros Project

This study assumes a 7,500 cfs isolated canal that includes the following:

- 1) A fish screen and pumping plant at Hood on the Sacramento River.
- 2) A 7,500 cfs canal from Hood to Clifton Court Forebay.
- 3) An interconnection between the Tracy Pumping Plant intake channel and Clifton Court Forebay.

This study uses the Ag/Urban Technical Team's Delta operation criteria which are the Delta Accord standards² with the following adjustments:

- 1) More restrictive export to Delta inflow ratios than the Delta Accord restrictions during the 31 day spring pulse flow and the November through January period.
- 2) The Delta Cross Channel gates are closed at all times except the gates can be opened during the year for short periods if required to maintain central and south Delta water quality.

² No changes to the Delta Accord Delta outflow requirements including the X2 requirements.

- 3) Increased Sacramento River in-Delta transport flows measured at Rio Vista.

The Los Vaqueros Project studied includes the following facilities:

- 1) A 3,000 cfs diversion and pumping plant from the California Aqueduct to Los Vaqueros Reservoir.
- 2) A 3,000 cfs release capability from Los Vaqueros back to the aqueduct.
- 3) A 1.0 MAF reservoir capacity with 100,000 AF of that capacity dedicated to the Contra Costa Water District.

The water supply developed by the Los Vaqueros Project was used in this study to meet unmet CVP and SWP demand south of the Delta (current level of development). The water supply developed by the Los Vaqueros Project could be used to offset CVP and SWP water supply losses due to implementation of environmental enhancement measures such as increased instream flows below any SWP or CVP reservoir, increased Sacramento River in-Delta transport flows measured at Rio Vista, reduced CVP and SWP export pumping from the south Delta during periods important to fish survival, and increased Delta outflow. The amount of water developed by the Los Vaqueros Project in thousands of acre-feet for environmental enhancement purposes can not be determined without knowing what the environmental enhancement measure(s) is or are.

The average annual benefits to the CVP and SWP water users of a 1 MAF Los Vaqueros Project are:

Period	Base	Delivery with a 1.0 MAF Los Vaqueros Reservoir	Difference
1922-92	5,472	5,840	368
1928-34	4,149	4,334	185
1986-92	4,345	4,602	257

This Los Vaqueros Project study assumes the diversion point for putting water into the reservoir is downstream of the Banks Pumping Plant. This assumption was adopted because 1) adding an additional south Delta diversion to the DWR model would be difficult and 2) my initial work had shown that the export to inflow ratio controlled often so the new diversion point from the south Delta would have little value. Output from this study shows clearly that my initial work was wrong. An additional 3,000 cfs capacity diversion from the south Delta into Los Vaqueros Reservoir would have a benefit when Banks P.P. capacity controls. The above Los Vaqueros Project benefits would increase with a south Delta diversion point. SWRI will start to work on coding changes to the DWR model so such a Los Vaqueros Project study can be conducted immediately.

Much of the water diverted into the Los Vaqueros Project with the 7,500 cfs Dual water transfer facilities must be pumped from the south Delta. The average monthly export to inflow ratio for the base with the increase in the exports caused by diversions Los Vaqueros Project storage shown in parenthesis are:

Period	1922-92	1986-92	1928-34
Oct	0.26 (0.00)	0.13 (0.00)	0.16 (0.00)
Nov	0.24 (0.01)	0.23 (0.00)	0.26 (0.00)
Dec	0.20 (0.03)	0.29 (0.01)	0.28 (0.03)
Jan	0.15 (0.04)	0.28 (0.02)	0.31 (0.01)
Feb	0.06 (.003)	0.04 (0.02)	0.11 (0.04)
Mar	0.07 (0.05)	0.12 (0.07)	0.11 (0.03)
Apr	0.22 (0.02)	0.26 (0.01)	0.27 (0.00)
May	0.08 (0.01)	0.13 (0.00)	0.11 (0.00)
Jun	0.27 (0.00)	0.18 (0.00)	0.11 (0.00)

The export to Delta inflow ratio increases due to diversion of Delta surplus flows to the Los Vaqueros Reservoir do not seem significant. As a final check, the average monthly increases in export levels for the months key to the fishery were calculated. The average monthly south Delta export measured in cfs for the base with the increase in the exports caused by diversion of Delta surplus flows into Los Vaqueros Reservoir shown in parenthesis are:

Period	1922-92	1986-92	1928-34
Oct	2,980 (60)	935 (0)	1,375 (0)
Nov	2,855 (155)	1,500 (0)	2,390 (0)
Dec	3,010 (520)	2,390 (70)	2,685 (230)
Jan	2,340 (1,140)	3,665 (195)	3,495 (415)
Feb	1,745 (1,480)	1,380 (905)	1,925 (890)
Mar	1,380 (1,580)	2,720 (1,925)	1,680 (860)
Apr	4,670 (910)	4,770 (175)	4,170 (220)
May	1,625 (50)	1,621 (0)	1,290 (60)
Jun	5,480 (30)	3,130 (0)	1,590 (0)

Federal and state fishery biologist may find the average 50% increase in exports due to diversions into Los Vaqueros Reservoir during the January through April period objectionable.

A Los Vaqueros Project as described above was done with a 10,000 cfs isolated facility. The purpose of this study was to determine the Los Vaqueros Project developed water supply increase, if any, and the degree the south Delta export increases are reduced.

The average annual benefits measured in thousands of acre-feet to the CVP and SWP water users of a 1 MAF Los Vaqueros Project with a 10,000 cfs Dual facility and the increase over the 7,500

cfs Dual facility study in parentheses are:

Period	Base	Delivery with a 1.0 MAF Los Vaqueros Reservoir	Difference
1922-92	5,472	5,856	384 (16)
1928-34	4,149	4,379	230 (45)
1986-92	4,345	4,634	289 (32)

The average monthly increases in export levels measured in cfs for the months key to the fishery were calculated. The average monthly south Delta export for the 10,000 cfs facility base with the increase in the exports caused by diversion of Delta surplus flows into Los Vaqueros Reservoir shown in parenthesis are:

Period	1922-92 (cfs)	1986-92 (cfs)	1928-34 (cfs)
Oct	1,850 (85)	810 (3)	925 (0)
Nov	1,950 (220)	1,500 (-10)	1,860 (45)
Dec	1,870 (440)	1,895 (0)	1,675 (250)
Jan	1,370 (530)	2,045 (5)	2,770 (-725)
Feb	560 (720)	485 (715)	180 (560)
Mar	880 (730)	1,860 (50)	1,080 (-80)
Apr	4,600 (860)	4,550 (400)	4,200 (90)
May	1,580 (30)	1,570 (0)	1,280 (10)
Jun	5,460 (35)	3,150 (-30)	1,515 (-515)

The 10,000 cfs Dual facility reduces south Delta pumping significantly when compared to the 7,500 cfs facility and likely eliminates the effect of diversions into Los Vaqueros Reservoir in all months except April when compared to the 7,500 cfs Dual facility base.

1.0 MAF Los Vaqueros Project + 1.2 MAF Sites Reservoir

In this study it is assumed that a 7,500 cfs Dual facility, 1.0 MAF Los Vaqueros Project, and 1.2 MAF Sites Project are in place. The assumptions for the two projects are the same as discussed for each earlier and a 7,500 cfs Dual facility. If there is insufficient surplus Delta flows to allow full diversions into Los Vaqueros and Sites, Sites was given first priority for diversion to storage.

If the Sites Project is operated to deliver 300,000 AF annually except during the 1929-34 period when a 33% shortage is applied each year, the water supply benefits of the Los Vaqueros Project to the export water users in TAF are:

Period	Base	Delivery with a 1.0 MAF Los Vaqueros Reservoir	Difference
1922-92	5,472	5,830	358 (-10)
1928-34	4,149	4,313	164 (-21)
1986-92	4,345	4,570	225 (-83)

The numbers in parenthesis represent the reduction in Los Banos Project water supply benefits when it is combined with the Sites Project and the Sites Project is given priority to surplus flows.

If the Sites Project is operated to deliver 400,000 AF annually except during the 1929-34 period when a 65% shortage is applied each year, the 1948-50 period when a 18% shortage is applied each year, and the 1987-92 period when a 25% shortage is applied each year, the water supply benefits of the Los Vaqueros Project to the export water users in TAF are:

Period	Base	Delivery with a 1.0 MAF Los Vaqueros Reservoir	Difference
1922-92	5,472	5,828	356 (-12)
1928-34	4,149	4,313	164 (-21)
1986-92	4,345	4,570	220 (-88)

The numbers in parenthesis represent the reduction in Los Banos Project water supply benefits when it is combined with the Sites Project and Sites is given priority to surplus flows.

Isolated Facility Size

The Ag/Urban Caucus Systems Subcommittee have asked the Technical Team to determine the size of an isolated canal that would optimize the following three purposes separately:

- 1) Water supply benefits.
- 2) Fishery enhancement (rehabilitation) benefits.
- 3) Water quality benefits at Banks and Tracy Pumping Plant.

As I understand the task, staff is to determine the size of the isolated facility if the purpose of the facility was to only improve water quality at the project pumping plants, for example. This memorandum attempts to address the water supply and fishery enhancement tasks.

The two purposes are so intertwined it is difficult to separate the two tasks and determine the size of the isolated facility if it were to be sized solely for the purpose of water supply or fishery enhancement. Water supply benefits of an isolated facility is dependent of the fishery protection operation criteria assumed. Therefore, it is not possible to determine the optimum sized isolated canal for maximum water supply benefits without considering fishery protection measures at the same time. I will take this argument to an absurd level to illustrate the point.

The fishery enhancement task can be met by satisfying the state and federal regulatory agencies biologists desire to reduce the current level of pumping from the south Delta significantly, increase the in-Delta transport flows in the San Joaquin and Sacramento rivers, close the Delta Cross Channel gates permanently, and increase the minimum Delta outflow over the Delta Accord requirements. All of this could be done today with no new facilities if there were no concern for the resultant Central Valley Basin water users water supply losses. Those losses would be significantly higher than the 1.0 MAF loss due to the Delta Accord. This answer to the Ag/Urban Caucus Systems Subcommittee question would, at best, not be helpful.

Water supply benefits could be maximized by 1) eliminating all fishery protection export constraints and flow requirements, and 2) reducing Delta outflow requirements to the outflow required to meet in-Delta agriculture and contractual water quality objectives at the pumps. The only new facilities needed would be the SWP south Delta portion of ISDP and moving the Contra Costa intake(s) to Clifton Court.

This answer to the subcommittee's water supply question would be useless since it could never be implemented. Therefore, I have changed the subcommittee's questions to: What size isolated canal is required to allow the fish requirements desired by the state and federal regulatory agencies biologists to be attained and increase the current CVP and SWP water supplies and reliability?

All of the Dual water transfer Ag/Urban Caucus studies done to date have included fishery protection measures that satisfy the current federal and state regulatory agencies fish biologist "wish list" for in-Delta changes to the Delta Accord standards except the Delta outflow increase. The outflow increase, measured in increased X2 days, was not included because there is no scientific justification for that requirement. The Ag/Urban Technical Team Delta operations criteria assumed with the Dual system provide habitat conditions that are better than required by all of the proposed b(2) actions except the Delta outflow increase. If it is assumed that the state and federal regulatory agencies except this criteria as adequate, the water supply benefits for three different size isolated canals with existing storage facilities measured against the Delta Accord base are:

Period	5,000 cfs Dual Water Transfer Facility (TAF)	7,500 cfs Dual Water Transfer Facility (TAF)	10,000 cfs Dual Water Transfer Facility (TAF)
1922-92	57	82	87
1928-34	-7	107	135
1986-92	64	147	163

With the Delta operations criteria used by the Ag/Urban Technical Team, a 10,000 cfs Dual system provides an increase (15%) in water supply benefits over the 7,500 cfs isolated facility. This trend would likely continue with larger facilities. The increase in benefits are likely not worth the increased cost. The 5,000 cfs Dual system provides significantly less benefits (66%) than the 7,500 cfs Dual system. The 7,500 cfs facility is or is close to the best size Dual facility with the Delta operations criteria used by the Ag/Urban Technical Team for optimizing water supply benefits. Finally, past studies have shown that the water supply benefits of each of the above isolated facilities could be increased by about 300,000 AF by adjusting the Delta Accord X2 requirements. Those adjustments can be justified because of 1) habitat improvements that will be made in the Chipps to Collinsville area and 2) improved in-Delta flow pasterns created by the Dual facilities.

The U.S. Fish & Wildlife Service (F&WS) staff have focused on new Delta facilities the last few months. Their logic is that the b(2) measures they have proposed are "band-aid" measures designed to increase the fish protection provided by the Delta Accord and those measures are limited by the existing Delta facilities. Therefore, the Ag/Urban Technical Team Delta operations criteria may not be deemed sufficient by F&WS and other state and federal regulatory agencies. Their primary objective seems to be to eliminate pumping from the south Delta or if that's not possible, minimize that pumping. The definition of "minimizing pumping" is not clear. The F&WS position has led to a CALFED position to focus on the Dual water transfer alternative and to work on various options for sizing the isolated canal. Given all of this, SWRI did studies to assist the Ag/Urban Caucus Systems Subcommittee determine the alternatives for sizing the isolated canal and the respective fishery benefits of each alternative.

The first study done was a 15,000 cfs isolated canal and existing storage facilities with no pumping from the south Delta being allowed. The Delta operation criteria used was the same Ag/Urban Technical Team criteria which was used for all of the studies discussed in this memorandum. The purpose of this study was to show the resultant water supply loss due to the fact that no pumping is allowed from the south Delta. The total exports for this study compared to the Delta Accord base measured in TAF are:

Period	Average Annual Exports	Difference
1922-92	5,489	-302
1928-34	4,236	-276
1986-92	4,371	-279

The water supply loss is due to:

- 1) The Ag/Urban Technical Team Delta operations criteria restricts diversions into the isolated canal at Hood during the March through June periods to protect eggs and larvae in the Sacramento River at Hood. Surplus Delta flows that can not be diverted at Hood can not be pumped from the south Delta.
- 2) The Rio Vista criteria controls project operations at times. Since water required to meet Rio Vista that is more than needed for Delta outflow can not be pumped from the south Delta, that water is lost to the projects.
- 3) The projects have no access to San Joaquin River flows.

The second study done was to test the amount of water supply lost in the above alternative due to the Hood March through June period diversion restrictions. In this study the Hood diversion restrictions were eliminated and the results compared to the Delta Accord base are:

Period	Average Annual Exports (TAF)	Difference (TAF)
1922-92	5,740	-54
1928-34	4,335	-170
1986-92	4,488	-158

Eliminating the Hood diversion restrictions reduced the water supply losses but the losses due to the constraint of no south Delta pumping are still very significant.

The next study assumed a 15,000 cfs isolated canal, existing storage facilities, Ag/Urban Technical Team Delta operations criteria, and allowed a maximum of 2,000 cfs export from the south Delta. The results measured in TAF:

Period	Average Annual Exports	Difference
1922-92	5,774	-20
1928-34	4,547	42
1986-92	4,705	59

This alternative brought the CVP and SWP water supply back to or close to the existing supply with the Delta Accord and existing facilities.

The next study assumed a 15,000 cfs isolated canal, existing storage facilities, Ag/Urban Technical Team Delta operations criteria, and allowed a maximum of 3,000 cfs export from the south Delta. The results:

Period	Average Annual Exports (TAF)	Difference (TAF)
1922-92	5,816	22
1928-34	4,566	61
1986-92	4,708	62

The 3,000 cfs allowable south Delta pumping does not change the water supply benefits in any significant way.

These studies show that the export level from the south Delta can be limited to relatively low levels with a 15,000 cfs isolated canal and the water supply benefits are also limited to small quantities. A 15,000 cfs isolated canal is problematic (policy argument not a technical argument). An isolated canal of that size eliminates the common pool premise because the projects will not need to pump from the south Delta in the summer months during extreme drought conditions

The average monthly pumping levels for the July through October period for the three 15,000 cfs isolated canal studies are:

- 1) 15,000 cfs canal with no pumping from the south Delta = 0 AF
- 2) 15,000 cfs canal with 2,000 cfs maximum pumping from the south Delta = 51,000 AF
- 3) 15,000 cfs canal with 3,000 cfs maximum pumping from the south Delta = 55,000 AF

During the 1929-34 and 1987-92 droughts that average drops to:

- 1) 15,000 cfs canal with no pumping from the south Delta = 0 AF
- 2) 15,000 cfs canal with 2,000 cfs maximum pumping from the south Delta = 32,000 AF
- 3) 15,000 cfs canal with 3,000 cfs maximum pumping from the south Delta = 55,000 AF

The ability of the exporters to rely solely on the 15,000 cfs isolated canal during emergency

drought conditions will raise significant in-Delta water users and environmentalists concerns. They will be concerned that a 15,000 cfs isolated facility would allow the export interests to abandon the Delta during extreme drought conditions and that the export water users would have sufficient political clout to pull that off.

Given all of the above, I decided to look at the possibility of meeting F&WS's desires with a smaller facility.

The average monthly, maximum monthly exports (plus % of time flows were within 10% of the maximum), and minimum monthly exports (plus % of time flows were within 10% of the minimum) for the three smaller isolated facilities with existing storage facilities are:

Month	5,000 cfs Dual Water Transfer Facility (cfs)	7,500 cfs Dual Water Transfer Facility (cfs)	10,000 cfs Dual Water Transfer Facility (TAF)
October	4,570	2,980	1,850
Max.	9,710 (20%)	7,220 (18%)	4,720 (17%)
Min.	0 (11%)	160 (13%)	160 (20%)
November	3,970	2,860	1,950
Max.	9,580 (7%)	7,090 (7%)	4,590 (17%)
Min.	820 (3%)	440 (11%)	160 (31%)
December	4,770	3,010	1,870
Max.	9,500 (17%)	7,010 (18%)	4,500 (14%)
Min.	1,690 (1%)	160 (3%)	160 (28%)
January	4,500	2,340	1,370
Max.	9,500 (10%)	7,010 (13%)	4,500 (17%)
Min.	0 (1%)	160 (21%)	160 (54%)
February	4,140	1,750	560
Max.	9,540 (11%)	7,040 (7%)	4,540 (6%)
Min.	0 (8%)	160 (25%)	160 (86%)
March	3,450	1,380	880
Max.	9,450 (4%)	6,960 (3%)	5,580 (3%)
Min.	0 (4%)	160 (31%)	160 (75%)
April	5,080	4,670	4,600
Max.	8,620 (3%)	8,620 (4%)	8,050 (7%)
Min.	1,580 (1%)	160 (1%)	160 (6%)
May	1,720	1,630	1,580
Max.	4,700 (3%)	3,430 (4%)	3,430 (4%)
Min.	0 (3%)	160 (1%)	310 (1%)

June	5,750	5,480	5,460
Max.	10,220 (8%)	10,180 (11%)	10,180 (6%)
Min.	0 (13%)	160 (11%)	160 (14%)
July	3,770	1,810	860
Max.	9,890 (11%)	7,400 (6%)	4,900 (7%)
Min.	0 (21%)	160 (45%)	160 (23%)
August	1,900	1,010	830
Max.	7,430 (1%)	4,940 (1%)	2,800 (3%)
Min.	0 (4%)	160 (47%)	160 (21%)
September	4,120	2,940	2,240
Max.	9,880 (14%)	7,390 (14%)	4,890 (13%)
Min.	970 (10%)	970 (4%)	160 (1%)

Increasing the size of the isolated canal from 5,000 cfs to 7,500 cfs and then to 10,000 cfs significantly reduces the average and maximum amount of water pumped from the south Delta except in the months of April, May, and June. The amounts of water pumped in April and June may be of concern to F&WS staff.

The question is what does F&WS want the maximum levels of pumping from the south Delta to be. We will not know for sure until discussions between the Ag/Urban Technical Team and F&WS staff begin. A 1987 agreement between F&WS and all the other state and federal regulatory agencies may give some indication. That agreement stated that the agencies wanted to reestablish habitat conditions that occurred during the 1960's. The agreement was submitted to the State Water Resources Control Board as an exhibit at that time. This agreement is where the different levels (1962, 1968 ect.) of X2 days was derived.

This biological goal was considered an unrealistic goal by the water industry at the time because the 1960's habitat conditions occurred prior to operation of the SWP and the CVP San Luis Unit. However, the pumping levels during the 1960's would give an indication of F&WS and other state and federal regulating agencies desires. The pumping from the south Delta during the 1960's was for the Delta-Mendota Canal (DMC) service area only. The average monthly pumping in cfs for the Delta-Mendota Canal were and are about:

Month	Tracy P.P. Pumping
Oct	1,100
Nov	900
Dec	900
Jan	1,000
Feb	1,900
Mar	1,700
Apr	2,250

May	3,000
Jun	4,000
Jul	4,600
Aug	4,200
Sep	2,100

Those export levels can not be maintained during the September through January period with any size isolated facility because of the need to put water into San Luis Reservoir unless the allowable export levels are restricted to those levels. Such a restriction would reduce the CVP and SWP water supplies significantly. However, those pumping levels are met some of the time with a 7,500 cfs or 10,000 cfs isolated canal. For example, the percentage of the years the above export levels are met for a 7,500 cfs facility by month are: Sep. 51%, Oct. 31%, Nov. 14%, Dec. 17%, and Jan. 49%. The percentage of the years the export to inflow ratio with a 7,500 cfs isolated canal exceeds 35% in September and October and is between 30% and 35% in November, December, and January are: Sep. 31%, Oct. 30%, Nov. 42%, Dec. 38%, and Jan. 30%.

With a 10,000 cfs facility the percentage of the years the above export levels are met by month are: Sep. 59%, Oct. 39%, Nov. 24%, Dec. 37%, and Jan. 59%. The percentage of the years the export to inflow ratio with a 10,000 cfs isolated canal exceeds 35% in September and October and is between 30% and 35% in November, December, and January are: Sep. 15%, Oct. 11%, Nov. 21%, Dec. 24%, and Jan. 17%.

The desire to reduce exports from the south Delta during this period is based on protecting late-fall and winter-run chinook salmon out-migrants. The Ag/Urban Caucus can argue credibly that the resultant south Delta export levels with a 5,000, 7,500, and 10,000 cfs isolated facility are sufficient to protect those species. The larger the facility, the smaller the export level during this period. The question is whether the benefits derived by going to a larger facility is required to mitigate project impacts or should be considered enhancement protection beyond the responsibility of the projects.

The historical DMC monthly export levels can be met for the months of May, July, and August with a 5,000, 7,500, 10,000 cfs isolated canal operation and the DMC export levels can be met for the months of February and March with a 7,500 and 10,000 cfs isolated canal.

The problem months are April and June. The pumping levels in those months is higher (significant in April) and can not be reduced regardless of the size of the isolated facility. Why? The Ag/Urban Technical Team Delta operation criteria restricts the amount of Sacramento River water that can be diverted at Hood to 15% of the flow during the April through June period except during critical years when that restriction is reduced to 35% for June. That restriction requires increased pumping from the south Delta to prevent a water supply loss during this period.

This restriction is designed to protect eggs and larvae in the Sacramento River during those months. The Ag/Urban Technical Team Delta Hood diversion restriction quantities are not based on a lot of biological data. They were intended as a starting point to initiate discussion. That has led to discussions related to restricting the diversions at Hood on a real-time basis and to achieve an agreed to mortality rate. Good idea but it can't be modeled, at least not yet. Using model output, my rough analysis shows that the DMC April export level can be met in all but the wettest years with a 7,500 cfs isolated canal if the export restriction is changed from 15% to about 35%.

The increase in the Hood diversion restriction reduction required to meet the DMC south Delta export targets would be less in June.

The bottom line is the F&WS staff and others must balance diversion restrictions at Hood against their desire to reduce exports in April and June. If that balancing does not occur, then the construction of a Dual facilities would lead to limited to zero water supply benefits. This sizing issue can be addressed only through discussions with F&WS and other state and federal regulatory agencies staff.

One thing is clear, however, the 5,000 cfs isolated facilities is not large enough to allow for reduction in south Delta exports to the historical DMC levels during the February through April period.

All of the above discussion on sizing the isolated facility for fishery benefits while protecting water supply benefits have assumed an isolated canal and existing CVP and SWP storage facilities. If the Los Vaqueros Project is included, diversions to Los Vaqueros Reservoir storage occur during the January through April period. The work described earlier in this memorandum shows that it may be necessary to go to a 10,000 cfs isolated facility to attain south Delta export levels that are acceptable to the regulatory agencies if the Los Vaqueros Project is added to the Ag/Urban Caucus alternative.

All of the above discussion on the size of a Dual facilities needed to meet the fishery regulatory agencies objectives are based on educated speculation. These are the same agencies we hope to reach agreement with on a long-term HCP. The optimum size isolated facility for providing fishery and water supply benefits can not be answered definitively until the Ag/Urban Caucus opens discussions with the fishery regulatory agencies to determine and refine the Delta operation criteria required to meet their objectives and the Caucus' desire to optimize water supply and water quality benefits.

Water Transfers

The Ag/Urban Caucus Systems Subcommittee also asked the Technical Team to consider the ability to transfer water purchased in the Sacramento Valley through the Delta to water users

south of the Delta. The isolated facility size will not be based on the ability to transfer water. However, the operational flexibility provided by a certain alternative could be a factor in the final selection of the size of the Dual facilities isolated canal.

If the Ag/Urban Technical Team Delta water criteria is used, all of the Dual isolated facilities with existing storage studied provide significant ability to transfer purchased water during drought periods including the 5,000 cfs facility. During drought, much of the water can be transferred through the canal. In other years the water must be transferred from the south Delta with the 5,000 cfs isolated canal and most but not all of the transfer water must be pumped from the south Delta with the 7,500 cfs isolated canal. In both cases significant quantities can be transferred in all but the wetter water years. In all cases, the window for water transfers is primarily the July through October 15 period. Spot checks show that quantities of 800,000 AF or more can be transferred during none drought years with any sized facility and more than that during drought periods with any size Dual facility. The key difference between the different size facilities is that with the larger facility more transferred water can be diverted at Hood rather than being pumped from the south Delta.

The worst case for water transfers would be new storage north of the Delta and that water is used to meet CVP and SWP demands. That water would be transferred to users south of the Delta during the same periods water transfers would be done. The study done that includes a 1.2 MAF Sites Project and 7,500 cfs isolated canal that delivers all of the Sites Project water to the users south of the Delta indicates that the ability to transfer water would not significantly reduce the ability to transfer water but would require all water purchase water to be pumped from the south Delta.

In my opinion, the ability to transfer water purchased in the Sacramento Valley to users south of the Delta can not be used to size an isolated facility. However, later in this process when a decision on a size is to be made on a 7,500 cfs or 10,000 cfs facility, for example, with the key factor being fishery enhancement, then the ability to transfer water could become the key factor swaying that decision towards a larger facility.

Conclusions

- ◆ A 1.2 MAF Sites Project is capable of delivering 400,000 AF to northern California water users and/or for environmental purposes in all years except in the following years when the reduction in deliveries would be:

Period	% Reductions
1929-34	65
1948-50	18
1987-92	25

The average annual delivery for this project is 367,000 AF. CALFED's cost estimate with Terry Erlewine's adjustments for this project is: capital cost = \$653 million - annual cost = \$51 million. Therefore, the cost per acre-foot delivered for this project would be \$140.

- ◆ A 1.2 MAF Sites Project is capable of delivering water to northern California water users and/or for environmental purposes 300,000 AF in all years except during the 1929-34 period when a 33% reduction in deliveries would be required. The average annual delivery for this project is 292,000 AF. The cost per acre-foot delivered for this project would be \$175.
- ◆ If the water developed by a 1.2 MAF Sites Project is delivered only to water users south of the Delta, the water supply benefits measured in TAF when compared to a base that includes the 7,500 cfs Dual facilities and existing storage facilities would be:

Period	Base Delivery	Delivery with a 1.2 MAF Sites Reservoir	Difference
1922-92	5,472	5,801	329
1928-34	4,149	4,353	204
1986-92	4,345	4,768	423

The average annual cost per acre-foot delivered is \$155.

- ◆ Delivering water from 1.2 MAF Sites Project to the CVP and SWP water users south of the Delta can be done without impacting the fishery with a 7,500 cfs or larger Dual facility.
- ◆ A 1.9 MAF Sites Project is capable of delivering 400,000 AF to northern California water users or for environmental purposes in all years except during the 1929-34 period when a 50% reduction in deliveries would be required. The average annual delivery for this project is 383,000 AF. CALFED's cost estimate with Terry Erlewine's adjustments for this project is: capital cost = \$883 million - annual cost = \$64 million. The annual cost per acre-foot delivered is \$167.
- ◆ A 1.9 MAF Sites Project is capable of delivering 300,000 AF to northern California water users or for environmental purposes in all years except during the 1929-34 period when a 10% reduction in deliveries would be required. The average annual delivery for this project is 297,000 AF. The annual cost per acre-foot delivered is \$215.
- ◆ The 1.9 MAF Sites Project does provide significantly greater quantities of water to be delivered than the 1.2 MAF Sites Project but does provide greater reliability. The

question is whether or not that increased reliability is worth the increased capital cost of the 1.9 MAF reservoir.

- ◆ The 1.0 MAF Los Vaqueros Project developed water supply is delivered to the CVP and SWP water users south of the Delta. This water can be used to increase the SWP and CVP water supplies or to offset the water supply impacts of environmental enhancement measures and/or increased northern California water use. The calculated water supply benefit of a 1.0 MAF Los Vaqueros Project measured in TAF with a 7,500 cfs Dual facility compared to a base that includes the 7,500 cfs Dual facilities and existing storage facilities would be

Period	Base	Delivery with a 1.0 MAF Los Vaqueros Reservoir	Difference
1922-92	5,472	5,840	368
1928-34	4,149	4,334	185
1986-92	4,345	4,602	257

The total capital cost of the 1.0 MAF Los Vaqueros Project is \$1,111 million and the annual cost is \$82 million. The average annual cost per acre-foot delivered is \$223.

- ◆ The average annual cost per-acre foot delivered of a 1.0 MAF Los Banos Project is \$269.
- ◆ Diversions into Los Vaqueros Reservoir occur during months that are critical to fish survival. The above water supply benefits are based on the assumptions that the Ag/Urban Technical Teams south Delta pumping constraints are acceptable to the fishery regulatory agencies. If the south Delta pumping restrictions become more restrictive then construction of the 1.0 MAF Los Vaqueros Project will very likely require a Dual facility isolated canal larger than 7,500 cfs.
- ◆ If both the 1.2 MAF Sites and 1.0 MAF Los Vaqueros projects are constructed and the Sites Project is given first priority for diverting surplus flows into storage, the benefits of the Los Vaqueros Project are reduced annually by about 10,000 AF during the 1922-92 period, 20,000 AF during the 1928-34 period, and 85,000 AF during the 1986-92 period. The two projects when operated together do compete at times for surplus flows but the reduction in total water supply benefits is relatively small.
- ◆ The isolated facility can not be sized to protect the environment without consideration for water supply impacts and vice versa.

- ◆ The Ag/Urban Technical Team Dual facilities assumed Delta operations criteria provide habitat conditions that are better than required by all of the proposed b(2) actions except the Delta outflow increase. The b(2) Delta outflow increase, measured in increased X2 days, was not included because there is no scientific justification for that increase. The water supply benefits measured in TAF for three different size isolated canals with existing storage facilities with the Ag/Urban Technical Team Delta operations criteria compared to against the Delta Accord base are:

Period	5,000 cfs Dual Water Transfer Facility	7,500 cfs Dual Water Transfer Facility	10,000 cfs Dual Water Transfer Facility
1922-92	57	82	87
1928-34	-7	107	135
1986-92	64	147	163

- ◆ The 10,000 cfs Dual system provides an increase (15%) in water supply benefits over the 7,500 cfs isolated facility. This trend would likely continue with larger facilities. The increase in benefits do not seem to be worth the increased cost. The 5,000 cfs Dual system provides significantly less benefits (66%) than the 7,500 cfs Dual system. The 7,500 cfs facility is or is close to the best size Dual facility with the Delta operations criteria used by the Ag/Urban Technical Team for optimizing water supply benefits.
- ◆ Past studies have shown that the water supply benefits of each of the above isolated facilities could be increased by about 300,000 AF if the Delta Accord X2 requirements are reduced. That reduction can be justified because of 1) habitat improvements that will be made in the Chipps to Collinsville area and 2) improved in-Delta flow patterns created by the Dual facilities.
- ◆ The CALFED cost estimate for various sized isolated facilities are:

Size	Total Capital Cost (\$ million)	Total Annual Cost (\$ million)
5,000 cfs	961	70
10,000	1,226	90
15,000	1,455	106

- ◆ If the F&WS and other regulatory agencies accept the Ag/Urban Technical Team's Delta operation criteria and are willing to execute a long-term HCP based on that criteria, then no further isolated facility studies are required.

- ◆ The U.S. Fish & Wildlife Service (F&WS) staff have focused on new Delta facilities the last few months. They have stated that the b(2) measures are "band-aid" measures designed to increase the fish protection provided by the Delta Accord and those measures are limited by the existing Delta facilities and legal constraints. Therefore, F&WS and others may wish to provide fishery enhancement measures that provide greater than the Delta Accord standards plus the b(2) actions such as eliminating or minimizing south Delta pumping with the Dual facilities.
- ◆ Eliminating pumping from the south Delta with a 15,000 cfs isolated facility would reduce current SWP and CVP water supplies by as much as 300,000 AF per year. Allowing a maximum of 3,000 cfs pumping from the south Delta with a 15,000 cfs isolated facility eliminates that water supply loss but caps the potential water supply benefits at unacceptably low levels.
- ◆ Increasing the maximum level of south Delta allowable pumping would not increase water supplies significantly and would likely exceed the export levels desired by F&WS and others. In addition, this alternative would require construction of a 15,000 cfs isolated canal which is expensive and likely politically "dead on arrival."
- ◆ An alternative approach is to look at the south Delta export levels with the 7,500 cfs and 10,000 cfs facilities and see if those levels could be adjusted to meet F&WS export level targets. The problem is we do not know what those targets are.
- ◆ F&WS and all other state and federal regulatory agencies executed a policy agreement in 1987 that stated their objective was to reestablish habitat conditions in the Delta that occurred during the 1960's. These agencies Delta policy positions have been consistent with that policy agreement for the past 10 years.
- ◆ The only pumping from the south Delta during the 1960's was for the Delta-Mendota Canal service area. The DMC monthly pumping levels are achieved by the 7,500 and 10,000 cfs isolated facilities in February, March, May, July, and August. The export levels are significantly lower with the 10,000 cfs compared to the 7,500 cfs facility.
- ◆ The DMC monthly pumping levels can not be met in April and June because the Ag/Urban Technical Team Delta operations criteria restricts the diversion of water at Hood to 15% of the Sacramento River flow in those months. The purpose of that restriction is to protect eggs and larvae in the river. If that restriction is relaxed to about 35%, the April and June DMC export levels can be met.
- ◆ The DMC export levels can not be met during the September through January period because of the need to divert water into San Luis Reservoir. The export levels from the south Delta are reduced significantly, however, by both the 7,500 and 10,000 cfs facilities. Are the DMC export levels needed during the September through January

period is the question.

- ◆ The export levels from the south Delta during this period with a 7,500 and 10,000 cfs facility in cfs are:

Month	7,500 cfs Facility		10,000 cfs Facility	
	Average	Max.	Average	Max.
September	2,940	7,390 (14)	2,240	4,890 (13)
October	2,980	7,220 (18)	1,850	4,720 (17)
November	2,860	7,090 (7)	1,950	4,590 (17)
December	3,010	7,010 (18)	1,870	4,500 (14)
January	2,340	7,010 (13)	1,370	4,500 (17)

The percentage of time exports are within 10% of the maximum is shown in the parentheses.

- ◆ The fish species of concern during this period are spring, late fall, and winter-run chinook salmon out-migrating smolts. The average export levels for both the 7,500 and 10,000 cfs facilities when combined with the Delta Cross Channel gates being closed are more than sufficient to protect these species. I think that is true for the maximum levels also because those export levels occur during very wet years. I'm sure F&WS and NMFS would be happy with the 10,000 cfs facility export levels during this period and should, in my opinion, be happy with the 7,500 cfs facility export levels.
- ◆ All of the above discussion on sizing the isolated facility for fishery benefits while protecting water supply benefits have assumed an isolated canal and existing CVP and SWP storage facilities. If the Los Vaqueros Project or some other south of the Delta surface storage facility is included in the final Ag/Urban Caucus alternative, it will likely be necessary to go to a 10,000 cfs isolated facility to attain south Delta export levels that are acceptable to the regulatory agencies.
- ◆ The discussion on the size of a Dual facilities needed to meet the fishery regulatory agencies objectives are based on educated speculation. These are the same agencies we hope to reach agreement with on a long-term HCP. The optimum size isolated facility for providing fishery and water supply benefits can not be answered definitively until the Ag/Urban Caucus opens discussions with the fishery regulatory agencies to determine and refine the Delta operation criteria required to meet the regulatory agencies objectives and the Caucus' desire to optimize water supply and water quality benefits.

- ◆ The ability to transfer water purchased in the Sacramento Valley to users south of the Delta can not be used to size an isolated facility. However, later in this process when a decision on a size is to be made on a 7,500 cfs or 10,000 cfs facility with or without additional storage, for example, with the key factor being fishery enhancement, then the ability to transfer water could become a significant factor swaying that decision towards a larger facility.

cc: Ag/Urban Caucus Systems Subcommittee